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BOTANICAL SKETCHES FROM THE ASIATIC TROPICS

By Henry Allan Gleason

II. The Philippines.

(*Continued from June Torreya*)

The problem of dealing with the cogon grasses in the Philippines is a serious one. The two chief species, *Imperata cylindrica* and *Saccharum spontaneum*, grow in dense masses, with perennial rhizomes, and are very difficult to eradicate when once established. Their seeds are distributed by the wind, and soon take possession of the abandoned native clearings. After the grasses have completely occupied such a field, it is used only for pasturage, or else abandoned completely. Fires burn off the cogon every dry season, destroying the young trees that may have germinated and even encroaching somewhat upon the forest. As a result of agricultural neglect and continued burning, the cogon has occupied an immense area in the Philippines, changing it from agricultural land to waste. Under native control, the cogon will never be reclaimed until the population ultimately becomes so dense that reclamation is an economic necessity. In the meantime, its area is gradually extending and yearly reducing the area available for agriculture.

Seen from a boat coming into Manila harbor from the north, the high mountains along the west coast of Luzon, north of Manila, appear to be half or more covered with cogon, with the forest occupying only the more precipitous slopes or the deeper ravines. North of Manila in the lowlands near Dagupan, the railway crosses an immense tract of cogon prob-

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ably ten miles wide and fully as long, absolutely uninhabited at present, but capable of producing immense crops of rice or sugar cane. In all probability it was so planted some time in the past, because cogon could scarcely have occupied so large a territory without previous cultivation and the aid of cogon fires. The mountains behind the city of Cebu are almost entirely deforested and covered with continuous fields of cogon, although they did in the past and could in the future support a luxuriant forest growth.

There are also some scattered shrubs in most of the cogon fields occupying the lower grounds near settlements. These

FIG. 6. The cogon grass association, with scattered small trees of *Bauhinia malabarica*, showing the sharp contact with the forest.

are chiefly of two species, *Bauhinia malabarica* and *Acacia Farnesiana*. Even they are killed by too frequent burnings. If the fires are kept off for a very few years, however, they will form such dense thickets that the cogon is killed off by excessive shading, and the forest is reëstablished as a consequence.

The interrelation of fire, cogon, and forest is beautifully shown on the slopes of the little hill Bulungbulo, adjacent to the College of Agriculture at Los Banos, and on several other low hills in the vicinity. The cogon grows in a dense jungle about six feet high, with a very small number of secondary

species. It occupies the eastern slopes of the hills almost completely, extends just to the ridge at the very top, and there meets the forest with a very sharp tension line. The margin of the forest is so abrupt that it looks like a solid vertical wall or hedge, and it follows the sharp ridge of the hill so closely that a single step into the forest may be a step of a foot or two downward as well. In one or two places here, where small depressions extend across the crest and into ravines on the east, or cogon side, *Bauhinia malabarica* has established itself. The trees are low, widely branched, with rounded spreading crowns,

FIG. 7. Road through a coconut orchard, Philippine Islands.

and look very much like the American black-jack oak, *Quercus marilandica*. Under them is very little underbrush, so that one walks through the forest about as easily as through a dense forest of second-growth in America. In fact, the Bauhinia forest here bears the same relation to the cogon association that the black-jack and black oak forest bear to the prairies in Illinois. In each case the rapid advance of the forest is prevented by fires, while these trees, because of their fire-resisting qualities, are the pioneer species in the advance. It is also probable, although we did not observe it, that this pioneer forest, like its analog in Illinois, is in turn succeeded by another forest of more mesophytic type.

No visitor to the Philippines should neglect the picturesque gorge near Pagsanjan, and the botanist will be especially interested in the trip because of the opportunity it gives to observe the coconut industry, which centers about that little city. Our own trip was made on one of the little steamers on Laguna de Bay as far as Paete, at the east end of the lake, and thence by a dugout canoe to Pagsanjan. This last part of the journey lies across about four miles of open water in the lake, through the marshes that obstruct the mouth of the Pagsanjan river, and then about four miles up the river itself. The northeast monsoon helped us across the open water in fairly quick time, but the wind died shortly after we entered the delta, so that the remainder of our trip was exceedingly slow. The boatmen tried to help matters by whistling for the wind, in a series of low plaintive notes, and once in a while they did get enough breeze to push on up the slow sluggish stream. If the progress was slow, it gave us all the better chance to observe the interesting aquatic vegetation of the marshes.

The chief species of floating vegetation is the well-known *Pistia stratiotes*, with yellow-green rosettes up to eight inches in diameter. In sheltered coves of Laguna de Bay it grows in dense masses, and isolated plants or groups of plants, washed out by waves or swept out by wind, are seen scattered all over the lake. Of course they live as well in the open water as in the sheltered bays. Once in the open water, the general tendency of the current is to carry them all slowly toward the Pasig river, which drains the lake into Manila Bay, passing enroute through the city of Manila. Standing on one of the bridges in that city, one sees a continuous procession of *Pistia* plants, usually cohering in masses two or three feet across, floating slowly down. The plants die when they reach salt water.

Pistia is also common on the made land near some of the villages along shore, and on the mud of rapidly forming deltas. This land form appears to be permanently rooted, and is somewhat smaller and much yellower than the floating form.

Among the numerous mouths of the Pagsanjan river, where

the water is quiet and free from wave action, there is a very obvious zonation. The zone next to the open water is characterized by *Jussiaea repens* and *Ipomoea aquatica*, both of them forming dense floating mats, and usually growing together. The width of these mats is apparently determined chiefly by the current, rather than by the depth, although we had no opportunity to observe the relation of the seedlings to the depth of water. *Jussiaea* is noteworthy for its development of aerenchyma on special pneumatophores along the stem at each node. These are adventitious roots, the nature of which is determined wholly or in part by the position of the leaf from whose base they arise. If the leaf is at the side or under surface of the stem, the roots are usually normal and positively geotropic; if on the upper side of the prostrate stem, all or most of them become pneumatophores and are negatively geotropic. Their size at maturity averages about an inch long by a quarter of an inch through, and there are three to seven at each node.

Behind the floating mat comes a reed thicket, in which *Phragmites karka* is most conspicuous and may be ten feet tall. As the soil accumulates and becomes firmer and drier, shrubs of *Pithecolobium dulce* and thickets of bamboo appear. These are in turn followed on still drier ground by coconut, banana, and other cultivated species, and the river banks are populous with fishing villages.

Pagsanjan is the cleanest, most picturesque, and most attractive village that we saw in the Philippines. Its streets are shaded with immense coconut palms, and the surrounding country for some miles around is covered with coconut orchards. In the city, almost every stage in the preparation of coconuts may be observed, but it is all carried on by native methods without the use of modern machinery.

The coconut orchards are usually planted in regular rows, and the trees may be eighty feet tall. Most of them show some crook or defect in the stem, the result of some typhoon in the past, and a few of them are actually prostrate at the base. The terminal portion which grew since the typhoon is, of course, erect. None of the orchards is carefully tended or kept free

from weeds, as would be done under American or European control, and in some of them the jungle of weeds is higher than one's head. On the sides of the trunk a small epiphytic orchid is abundant. Many of the trunks have been hacked with a bolo, probably under the superstition that their productivity is increased by such treatment, and such scars are usually overgrown with lichens. Some of them produce nuts which are completely filled with endosperm, without the usual hollow center filled with milk. These trees, when known, are usually marked with some distinctive sign. To facilitate picking the ripe fruit, pairs of bamboo poles are frequently lashed from the

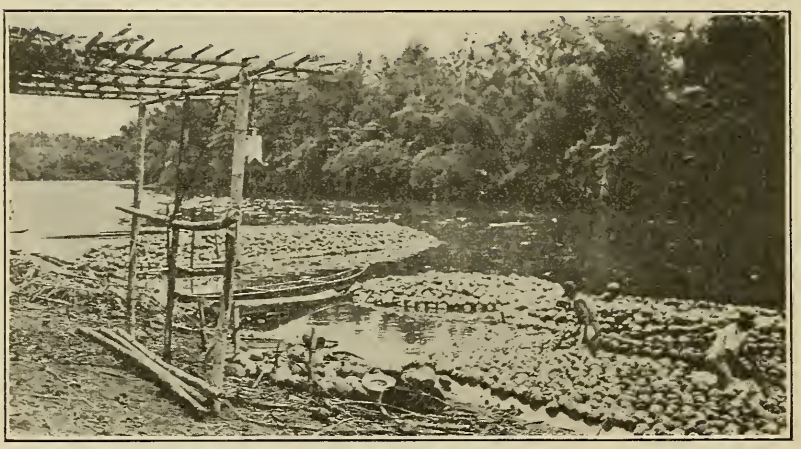

FIG. 8. Unloading coconut rafts on the Pagsanjan River, Philippine Islands.

top of one tree to the top of the next, about three feet apart, and the pickers travel across on them without having to return to the ground.

Immense quantities of coconuts are exported by steamer down the river and across the lake to Manila. Most of these are brought into Pagsanjan by raft. Long slender bamboos are tied or spliced into a huge circular or oval frame, floating on the river. To it is tied a circle of coconuts, still in the husk, and the interior of the frame is then filled up and piled high with others. Such a raft may be up to fifty feet long by half as wide, and will contain some thousands of nuts.

In the city a copra mill may be easily located by the rank pungent odor. They are all crudely built shacks, situated by preference on a hillside. Inside the mill, the operator sits on a tool shaped something like a child's hobby horse, but armed with a sharp spike for the head. After the nut is removed from the husk, it is split open and the kernel removed upon this spike with astonishing deftness. The husk is used for coconut fiber, and the shell for fuel. Under the mill is a stone-walled pit, and the floor above it is covered with strips of bamboo. On this the kernels are spread, the fire of shells built in the pit below, and the smoke and heat dry the kernels into copra. A great deal of this is exported directly, but in some mills there are also primitive oil presses. These consist of a large split log and a trough beneath. Copra is placed between these logs, pressure is applied by huge hand screws, and the oil drips out into the trough.

Along the city street, one sees everywhere piles of coconuts, of husks, of shells for fuel, of seedlings waiting to be transplanted. Coconut trunks are used for building, and the poorer houses have their sides and roof of coconut thatch. Even the prevailing street game of the children, something like hop-scotch, is played with a coconut shell.

The trip from Pagsanjan to the gorge is made by the native bancas up the river. For a considerable distance its exceedingly rapid current is confined within vertical walls several hundred feet high, and at the upper end of the gorge are some very picturesque falls. The sides of this gorge are clothed with a dense mat of climbers, epiphytes, and rock plants. Fig trees attach themselves as epiphytes on the cliff, and send their roots down to the water's edge. Other epiphytes attach themselves to the figs. Palms and tree ferns establish themselves in the tangle. Aroids grow in vertical strips under the smaller falls, where they are constantly drenched by the spray. Thickets of a willow-like *Eugenia* grow on the gravel bars near the river. All combine to present a most varied and interesting display of tropical vegetation, whose quiet colors and motionless foliage are in sharp contrast to the turbulent waters of the stream.

It is only about twenty miles across country in a direct line from Los Banos to the famous Taal volcano, whose eruption in January, 1911, caused the loss of fifteen hundred lives and the destruction of an immense amount of property. The volcano is situated on a small island in the center of a lake. Since the original vegetation was almost entirely destroyed by the eruption,* the island offers an interesting opportunity to observe the reëstablishment of vegetation, under conditions somewhat similar to those on Krakatoa.

It will be remembered that Krakatoa, whose vegetation has attracted so much attention during the last thirty years, is

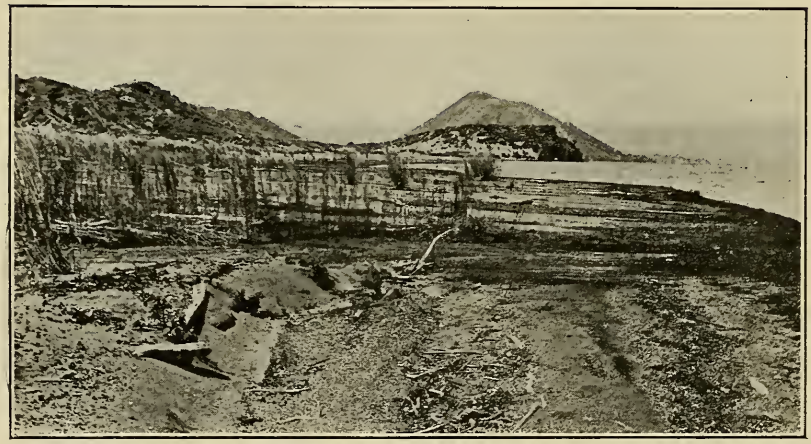

FIG. 9. Shore of Lake Bombon on Taal Island, Philippine Islands, with *Phragmites Karka* and *Ipomoea pes-caprae.*

located off the west coast of Java, surrounded on all sides by salt water, and separated from the mainland by a considerable distance. Naturally the immigration of vegetation must go on more slowly under such circumstances. From Taal to the mainland, the width of open water is in no place more than four miles, so that wind-borne seeds can be readily carried.

Desiring to observe the condition of vegetation there after nearly three years development, we started on October 24 from

* For a graphic description of the eruption, with illustrations of the volcano in action, see the article by Worcester, in the National Geographic Magazine for April, 1912.

Los Banos to Tanauan by rail. The party consisted of four Americans and about twenty Filipino students of the College of Agriculture. From Tanauan the Americans started by carromata toward the shore of the lake. The roads were exceedingly rough, and in places almost impassable, so that the carromatas had to be abandoned when about halfway to Bombon Lake, and the rest of the trip was made by horseback. Even then, the students who walked reached the lake well ahead of us.

It was too late to get boats to Volcano Island after our arrival, and there are no accommodations whatever for strangers in the little village of Banadero, on the shore of the lake. The students took refuge in the houses of the natives, while the four Americans climbed to the flat roof of the Seismological Observatory, and spent the night rolled in their blankets under the stars.

The shore of Bombon Lake is bordered by mountains or high hills on every side, except at the northeast in the direction of Tanauan. Here there is a gradual slope to a table land estimated at five hundred feet above the lake. At the north of the lake is a high plateau with steep southern escarpment facing the lake. The crest is mostly covered with forest and cogon, and the sparse cultivation is confined to the foothills. At the south, on the east side of the lake, stands Mt. Macolod, with its western face almost vertical for about a thousand feet. There are some other precipitous islands and headlands in the same vicinity, covered with scattered groves and much cogon, and seemingly connected with the general table land to the east. Volcano Island, examined through the field glasses from a distance of five miles, showed a very sparse vegetation and great areas of bare yellow-brown volcanic ash. Its surface is rolling, with several isolated peaks, but culminates in the volcanic peak proper, around which the rim of the broad crater reaches heights of a thousand feet.

The shore of the lake is composed principally of black volcanic sand, and the principal vegetation is a mixed association of the creeping morning glory, *Ipomoea pes-caprae*, and the legume *Canavalia lineata*. These plants cover the sand with their long prostrate stems, and their erect leaves are on petioles

nearly a foot long. The flowers of both are partially hidden beneath the foliage. *Ipomoea pes-caprae* has simple leaves, while those of *Canavalia* are compound. The leaflets of the latter, however, resemble whole leaves of the former so closely in shape, size, and venation, that we walked through the mats for some minutes before we observed that there was a second species at all. It made a most striking illustration of the frequent tendency of unallied species of the same association to present the same vegetative form.

Back of the beach proper, the flat meadows are thickly sprinkled with small rocks of remarkably uniform size, all probably deposited there during some eruption of the volcano. Most of them are heavy black lava, some with a mixture of a red iron compound, but there are some of pumice as well. Thickets of *Acacia Farnesiana* were coming up freely over these meadows. Along the paths and at the base of the low hills were mixed thickets of numerous species.

A small stream which entered the lake here is bordered by numerous plants of a tall aroid, apparently an *Alocasia*. Its broad triangular leaves are a yard long, and clustered at the summit of an erect caudex three or four feet high and ten inches in diameter. The plants nearest the stream were being undermined by the meandering of the current, and plants still alive may occasionally be washed down stream and into Bombon Lake. One such plant was seen on the lake shore, still alive and apparently in good condition, and there is no reason why the species should not sometimes reach the shore of the volcanic island and colonize there.

There was considerable delay in arranging for our transportation by water across to the volcano. Part of that may be attributed to the general habit of procrastination of the Filipino, part to the difficulty of making our wants known, and part to superstition. No one would venture on such a trip until after the Americans had started. With us and our cargadores, or carriers, on the way, the students followed very quickly. The native boat, or banca, is a dug-out, with single or double outriggers of bamboo. It is very narrow, not exceeding

twenty inches, and of about the same depth. The boatmen use paddles or oars, in the latter case using their toes for an oar-lock, or run up a sail when the wind is favorable. They apparently have no knowledge of tacking across or against the wind. Outriggers make the boat ride with extreme steadiness, and prevent capsizing absolutely. In fact, the bamboo outrigger, with its hollow internodes, might be regarded as the forerunner of the watertight compartment of the modern ocean liner. Such a rigging certainly makes the banca safe, and must be very valuable in stormy weather, but in a moderate wind it is uncomfortable. The banca refuses completely to rise with the waves,

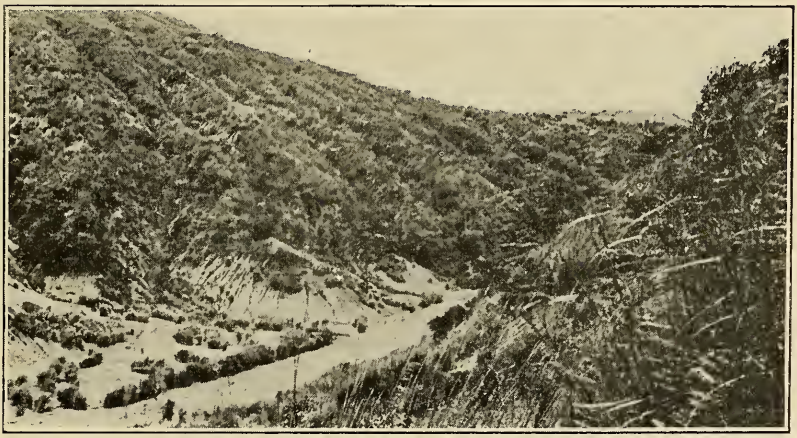

FIG. 10. A newly-formed ravine on Taal volcano, Philippine Islands, showing the dense growth of cogon grass.

but ploughs straight through them. Every little wave comes over the bow or gunwales and drenches the occupants. On our return trip, against a stiff breeze, one boatmen was constantly employed bailing, and the passengers were completely soaked.

As we approached the volcano, the north shore of the island was seen to be bordered by numerous islets of various sizes, from mere rocks to others of several acres. The distance of these from the volcano certainly sheltered their vegetation somewhat during the recent eruption. Also the deposit of ash was less, and the distance to the mainland is much shorter. All of these

conditions contribute to a more luxuriant type of vegetation They are covered chiefly with cogon, with small thickets of shrubbery in a few places. Of especial interest were several clumps of bamboo, not only near the shore, but also back some distance inland, and a single clump of banana. Both of these species are intimately associated with man and are seldom or never seen away from cultivation. Since the government now forbids settlements on the island, we considered these two species as relics antedating the eruption.

Our boats passed between several of these outlying islets, and finally landed on a broad flat beach of volcanic ash. This was entirely of deltal origin, and was composed of material washed down from the hills behind. At either side of the delta, the hills came to the water's edge, and were densely covered by cogon grass. We had scarcely landed before some of the boys set fire to it, and the flames ran up the hill with a great crackling. Firing the cogon seems to be a common practice, and of course effectually prevents the establishment of the forest.

Most of the delta was without vegetation. In the moist spots were green algae, and loose patches of the tall reed, *Phragmites karka*. There were a few mats of *Ipomoea pes-caprae*, a few shrubs of *Acacia Farnesiana*, a few tufts of cogon grass, a single plant of the yellow-flowered composite *Wedelia biflora*, and plenty of small driftwood. The latter was found far enough up the delta to prove its insular origin, although *Ipomoea*, *Wedelia*, and *Acacia* have probably reached the island by water. Near the upper end of the delta was a single small plant of an *Amorphophallus*, its stem about sixteen inches high, and much too small comparatively for its large underground parts. We believed that it had persisted through the eruption, and had later washed down to the delta and established itself there.

This delta was the deposit from an immense ravine which entered it from the south and which had its inception high up on the outer wall of the volcano proper. We turned inland along the side or crest of its west wall twoard the crater. During the first part of the way, the vegetation was a dense growth of healthy cogon, forming close jungles much higher than one's

head. *Saccharum* and *Imperata* were both present, and with them occasionally another unidentified species which closely resembled in vegetative habit the American *Andropogon furcatus*. One outlying promontory of the island was occupied chiefly by this, with an effect much like that of the bunch-grass association of the prairie states. Mixed with the dense cogon were scattered shrubs of various species. Commonest among them by all odds was *Acacia Farnesiana*, sometimes well loaded with pods. Among the other less common species were a *Cissus*, *Tabernaemontana* sp., *Cordia myxa*, *Desmodium tenellum*, an *Indigofera*, and a gourd with warty, orange, melon-like fruits five inches in diameter. The size and age of all these was such that they seemed to be recent introductions since the eruption.

As we gradually ascended the sides of the mountain and penetrated farther inland, the vegetation became more and more sparse. This decrease seemed to be correlated with the proximity of the crater, rather than with the altitude. The cogon began to disappear first from the crests of the ridges, then from the bottoms, until half way to the crater it occupied only the smaller ravines, which it colonized in long strips. The last ascent of the crater was considerably steeper, and here the cogon disappeared entirely, exposing hundreds of acres of perfectly bare yellow-brown ash.

With the torrential tropical rains, and with a loose soil of ash entirely unprotected by vegetation, the rapidity of erosion is very great. It has resulted in the working out within three years of a most elaborate system. Every feature of erosive activity and result taught by physiography may be observed within a very little distance, from stream piracy to meandering, and viewed from the summit of the mountain the surface of the island looks like a physiographic model.

Because of the great relief, the erosion is at first chiefly in depth, and results in a narrow canyon with vertical walls and flat bottom. One may find such a canyon a foot wide and a foot deep, and by stepping into it and following it to the lake, observe its whole history. It becomes rapidly deeper, while preserving its vertical sides, and an obstruction or hard stratum in

the ash may be followed by a vertical drop of several feet. At such places it is narrowed in proportion, and we passed through canyons where it was necessary to walk sidewise, while the canyon walls were twenty feet high on either side. As the canyon approaches base level, its curving sides and the location of gravel deposits in the bottom, show that it has begun to meander. At this stage, the canyon which we explored was two hundred feet wide at the bottom, and the vertical sides were at least a hundred feet high. Exit from such a canyon is impossible, and the explorer must follow it to one end or the other.

The rim of the crater is exceedingly narrow. The inner wall is quite precipitous, of rough rocks in contorted strata, while the outer is also very steep. The two meet at such a sharp angle that one must watch every step. The crater is about a mile and a half across, and the crater lake at the bottom over half a mile in diameter. With some difficulty we made our way to the bottom, finding the whole interior of the crater absolutely without vegetation, and with an odor strongly suggestive of a chemical laboratory. The temperature of the water in the lake was about blood heat, or a little warmer, while that of the air was certainly not much less.

Dr. Gates has prepared a careful description of the vegetation of the island, which gives a much fuller account than possible here. In general it may be said, that practically all of the vegetation has colonized on the island after the eruption, that the chemical nature of the ash and the proximity of the mainland has permitted a more rapid development than on Krakatoa, where the fixation of atmospheric nitrogen seemed to be a prerequisite, and that wind has been the chief agent in the immigration. With the proximity of Taal to botanical centers at Los Banos and Manila and its comparative accessibility, it should be observed at frequent intervals, and should offer interesting conclusions concerning the post-volcanic development of vegetation.

The natives have a superstition that the eruption was caused by an old man who lived in the crater lake, and who was very

averse to noise. Since the villagers on the island made too much noise to suit him, he destroyed them by way of punishment. The boatmen with us kept very quiet while on the island, and never left the landing place. The students were also rather subdued, and only one of them had the courage to climb into the volcano, my cargadore Elvina. When we returned and met the other students at the landing place, Elvina reported that the old man had risen up from the lake, and had talked

FIG. 11. The last outposts of cogon on the upper slopes of Taal volcano, Philippine Islancs.

with the Americanos, a story which seemed to add considerably to the respect of the boatmen for us.

We returned to Banadero in the evening, spent another night on the observatory roof, walked to Tanuan in the morning, and returned to Los Banos by rail.

(To be continued.)

SHORTER NOTES

A LETTER FROM GREENLAND.—"Just a message from this land of Thule, as the Danes call the unglaciated tract about Wolstenholme Sound, where I am studying the plants, rocks, and birds this summer, the guest of the Danish explorer Knud